26/06/2022
Morning

# Memory Based Answers \& Solutions 

Time : 3 hrs .

# JEE (Main)-2022 (Online) Phase-1 

(Physics, Chemistry and Mathematics)

## IMPORTANT INSTRUCTIONS:

(1) The test is of $\mathbf{3}$ hours duration.
(2) The Test Booklet consists of 90 questions. The maximum marks are 300 .
(3) There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage. Each part (subject) has two sections.
(i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries $\mathbf{4}$ marks for correct answer and $\mathbf{- 1}$ mark for wrong answer.
(ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and $\mathbf{- 1}$ mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

## PHYSICS

## SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

## Choose the correct answer:

1. If the time period of simple pendulum is $T$, then find its time period inside a lift moving upward with an acceleration of $g \mathrm{~m} / \mathrm{s}^{2}$.
(1) $T$
(2) $2 T$
(3) $\frac{T}{2}$
(4) $\frac{T}{\sqrt{2}}$

## Answer (4)

Sol. $\because T_{1}=2 \pi \sqrt{\frac{l}{g}}$

$$
\begin{aligned}
& T_{2}=2 \pi \sqrt{\frac{l}{g+a}} ; a=g \\
& \Rightarrow \quad \frac{T_{1}}{T_{2}}=\sqrt{\frac{g+g}{g}}=\sqrt{2} \\
& \Rightarrow \quad T_{2}=\frac{T_{1}}{\sqrt{2}}=\frac{T}{\sqrt{2}}
\end{aligned}
$$

2. A ball is thrown vertically upward. At the maximum height which of the following is zero?
(1) Momentum
(2) Potential Energy
(3) Acceleration
(4) Force

## Answer (1)

Sol. At top most position, speed $=0$
$\Rightarrow$ Momentum $=0$ at top position
3. In the diagram value of current $/$ is

(1) 1 A
(2) 2 A
(3) 0.5 A
(4) 4 A

Answer (1)

Sol. $R_{\mathrm{eq}}=\frac{16}{2}+2$


$$
\begin{aligned}
& =10 \Omega \\
\therefore \quad & I=\frac{10}{10}=1 \mathrm{~A}
\end{aligned}
$$

4. When do you experience weightless in a lift?
(1) Moving upward with constant velocity
(2) Moving upward with constant acceleration
(3) Moving downward with constant velocity
(4) Moving downward with constant acceleration

## Answer (4)

Sol. When a lift moves down with acceleration equal to $g$, then we experience weightlessness.
5. A ring of mass $M$ and radius $R$ is rotating with angular velocity of $\omega=2 \mathrm{rad} / \mathrm{sec}$. Two point masses of equal mass $m$ are placed at diametrically opposite points. The value of new angular velocity will be
(1) $\frac{M}{2 M-m}$
(2) $\frac{2 M}{M+2 m}$
(3) $\frac{2 m}{M+m}$
(4) $\frac{M}{M+2 m}$

## Answer (2)

Sol. MOI $\Lambda_{1}=M R^{2}$
$\mathrm{MOI} \mathrm{I}_{2}=M R^{2}+(2 m) R^{2}$
$\therefore$ By COAM,
$l_{1} \omega_{1}=I_{2} \omega_{2}$
$\Rightarrow M R^{2} \times 2=(M+2 m) R^{2} \times \omega_{2}$
$\Rightarrow \omega_{2}=\frac{2 M}{M+2 m}$
6. According to the graph the value of energy density when strain is $5 \times 10^{-10}$ is

(1) $4.0 \times 10^{-6} \mathrm{~J} / \mathrm{m}^{3}$
(2) $1.5 \times 10^{-8} \mathrm{~J} / \mathrm{m}^{3}$
(3) $2.5 \times 10^{-8} \mathrm{~J} / \mathrm{m}^{3}$
(4) $2.5 \times 10^{-10} \mathrm{~J} / \mathrm{m}^{3}$

Answer (3)
Sol. Energy density, $u=\frac{1}{2} \times$ stress $\times$ strain
$=\frac{1}{2} \times 100 \times 5 \times 10^{-10}$
$=2.5 \times 10^{-8} \mathrm{~J} / \mathrm{m}^{3}$
7. An aeroplane is flying horizontally with the velocity of $200 \mathrm{~m} / \mathrm{s}$. When it is just above a cannon, the cannon fires a shell at a speed of $400 \mathrm{~m} / \mathrm{s}$ at an angle of $\theta$ with horizontal. The value of $\theta$ for which shell hits aeroplane.
(1) $45^{\circ}$
(2) $30^{\circ}$
(3) $37^{\circ}$
(4) $60^{\circ}$

Answer (4)

Sol.


To hit the plane,
$v_{1}=v_{2} \cos \theta$
$\Rightarrow 200=400 \cos \theta$
$\Rightarrow \quad \cos \theta=\frac{1}{2}$
$\Rightarrow \quad \theta=60^{\circ}$
8. $\rho=\frac{\alpha}{\beta} \log _{e}\left(\frac{k x}{\beta}\right), \rho$ is dimensionless.

If $k=$ kinetic energy
$x=$ displacement
Find dimension of $\alpha$
(1) $\mathrm{M}^{0} \mathrm{~L}^{-1} \mathrm{~T}$
(2) $\mathrm{ML}^{3} \mathrm{~T}^{-2}$
(3) $\mathrm{ML}^{2} \mathrm{~T}^{-1}$
(4) $\mathrm{ML}^{0} \mathrm{~T}^{-3}$

Answer (2)

Sol. $\because\left[\frac{k x}{\beta}\right]$ is dimensionless
$\Rightarrow[\beta]=[k x]$

$$
=\mathrm{ML}^{2} \mathrm{~T}^{-2} \times \mathrm{L}=\mathrm{ML}^{3} \mathrm{~T}^{-2}
$$

$\therefore[\rho]=\left[\frac{\alpha}{\beta}\right]$
$\Rightarrow[\alpha]=[\beta]$
$\Rightarrow[\alpha]=\mathrm{ML}^{3} \mathrm{~T}^{-2}$
9. If a point of mass 0.5 kg is dropped from a height of 10 m . At what height is the magnitude of velocity is equal to the magnitude of acceleration of mass $\left(g=10 \mathrm{~m} / \mathrm{s}^{2}\right)$
(1) 7.5 m
(2) 2 m
(3) 5 m
(4) 6 m

Answer (3)
Sol. $\because a=10 \mathrm{~m} / \mathrm{s}^{2}$
And, $v=g t$
$\Rightarrow 10=10 \times t$
$\Rightarrow t=1 \mathrm{~s}$
$\therefore h=10-\frac{1}{2} g t^{2}$
$=10-\frac{1}{2} \times 10 \times 1^{2}$

$$
=5 \mathrm{~m}
$$

10. If length of the wire is increased by $0.4 \%$ through stretching then find the percentage change in resistance of the wire.
(1) $0.4 \%$
(2) $0.2 \%$
(3) $0.6 \%$
(4) $0.8 \%$

## Answer (4)

Sol. $\because R=\frac{\rho l}{A}$

$$
\begin{aligned}
\Rightarrow \% \Delta R & =\% \Delta I+\% \Delta A \\
& =0.4 \%+0.4 \% \\
& =0.8 \%
\end{aligned}
$$

11. What is the efficiency of Carnot engine between steam point and ice point?
(1) $26.80 \%$
(2) $36.71 \%$
(3) $46.71 \%$
(4) $56.6 \%$

Answer (1)
Sol. $\eta=1-\frac{T_{1}}{T_{2}}$
$=1-\frac{273}{373}$
$=\frac{100}{373}$
$\simeq 26.80 \%$
12. For the nuclear reaction
${ }_{92}^{238} \mathrm{U} \rightarrow{ }_{82}^{206} \mathrm{~Pb}$
The number of $\alpha$ and $\beta$ particles emitted respectively are
(1) 8,6
(2) 6,8
(3) 8,4
(4) 6,4

## Answer (1)

Sol. Number of $\alpha$ particles $=\frac{238-206}{4}$

$$
\begin{aligned}
& =\frac{32}{4} \\
& =8
\end{aligned}
$$

Let number of $\beta$-particles $=x$
Then, $8 \times 2-x(92-82)$
$\Rightarrow x=16-10=6$
$\therefore \quad$ Number of $\beta$-particles $=6$
13. An electron moving with speed $v$ has wavelength equal to that of a photon moving with speed $c$, Then the ratio of their energies is
(1) $\frac{v}{2 c}$
(2) $\frac{2 v}{c}$
(3) $\frac{v}{c}$
(4) $\frac{c}{v}$

Answer (1)
Sol. $\because \lambda_{1}=\lambda_{2}$
$\Rightarrow \frac{h}{\sqrt{2 m_{e} E_{e}}}=\frac{h c}{E_{R}}$
And, $E_{e}=\frac{1}{2} m_{e} v^{2}$
$\therefore \quad \frac{1}{\sqrt{2 \times \frac{2 E_{e}}{v^{2}} \times E_{e}}}=\frac{c}{E_{p}}$
$\Rightarrow \frac{v}{2 E_{e}}=\frac{c}{E_{p}}$
$\Rightarrow \frac{E_{e}}{E_{p}}=\frac{v}{2 c}$
14. An alpha particle and a proton moving with same speed are accelerated in uniform magnetic field, then find the ratio of radius of alpha particle to that of proton.
(1) $4: 1$
(2) $1: 4$
(3) $2: 1$
(4) $1: 2$

Answer (3)
Sol. $\because R=\frac{m v}{q B}$

$$
\begin{aligned}
\Rightarrow \frac{R_{\alpha}}{R_{P}} & =\frac{m_{\alpha}}{q_{\alpha}} \times \frac{q_{P}}{m_{P}} \\
& =\frac{4}{1} \times \frac{1}{2} \\
& =\frac{2}{1}
\end{aligned} \Rightarrow \text { Ratio }=2: 1
$$

15. Magnetic flux in a region is given by
$\phi=4 t^{3}+2 t^{2}+t+1$
If the resistance of the loop is $R=34 \Omega$, the current unit at $t=1$, is
(1) 0.5 units
(2) 2 units
(3) 0.8 units
(4) 4 units

## Answer (1)

Sol. $\phi=4 t^{3}+2 t^{2}+t+1$
$\Rightarrow|\varepsilon|=\frac{d \phi}{d t}=12 t^{2}+4 t+1$
At $t=1, \varepsilon=12+4+1=17$
$\therefore$ Current $I=\frac{\varepsilon}{R}$

$$
=\frac{17}{34}=0.5 \text { units }
$$

16. Graph is plotted between acceleration due to gravity of earth $g$ and distance from centre of earth $r$. Then choose the correct graph

(3)


Answer (1)
Sol. $g(r)= \begin{cases}g_{0} \frac{r}{R} & \text { for } r \leq R \\ g_{0} \frac{R^{2}}{r^{2}} & \text { for } r>R\end{cases}$
So the graph will be

17. Find the ratio of orbital radius for the second orbit of hydrogen atom and third orbit of $\mathrm{Li}^{++}$.
(1) $\frac{3}{4}$
(2) $\frac{4}{3}$
(3) 2
(4) $\frac{1}{2}$

Answer (2)
Sol. $\because \quad r_{n}=r_{0} \times \frac{n^{2}}{Z}$
$\Rightarrow \frac{r_{H}}{r_{L i}}=\frac{n_{H}^{2}}{n_{L i}^{2}}=\frac{Z_{L i}}{Z_{H}}$
$=\frac{2^{2}}{3^{2}} \times \frac{3}{1}=\frac{4}{3}$
18. Consider two reflections of a ray as shown:


If the angle of reflection at $B$ is $30^{\circ}$, find the net deviation of the ray
(1) $180^{\circ}$
(2) $210^{\circ}$
(3) $240^{\circ}$
(4) $150^{\circ}$

## Answer (2)

Sol. Using law of reflection:


$$
\begin{aligned}
\therefore \text { Net deviation }=90^{\circ} & +\left(180^{\circ}-60^{\circ}\right) \\
& =90^{\circ}+120^{\circ}=210^{\circ}
\end{aligned}
$$

19. The extension in wire, kept vertical, is $10^{-4} \mathrm{~m}$ when the experiment is done on earth's surface. If the experiment is another planet, the extension is $6 \times 10^{-5} \mathrm{~m}$. Find acceleration due to gravity due to the planet [Given : $g_{\text {earth }}=10 \mathrm{~m} / \mathrm{s}^{2}$ ]
(1) $6 \mathrm{~m} / \mathrm{s}^{2}$
(2) $8 \mathrm{~m} / \mathrm{s}^{2}$
(3) $9 \mathrm{~m} / \mathrm{s}^{2}$
(4) $10 \mathrm{~m} / \mathrm{s}^{2}$

Answer (1)
Sol. The extension is directly proportional to weight.

$$
\begin{gathered}
\Rightarrow \frac{\Delta x_{1}}{\Delta x_{2}}=\frac{g_{1}}{g_{2}} \\
\frac{10^{-4}}{6 \times 10^{-5}}=\frac{10}{g_{2}} \\
\\
g_{2}=6 \mathrm{~m} / \mathrm{s}^{2}
\end{gathered}
$$

20. A capacitor of capacitance $C_{1}$ was initially charged to voltage $V_{0}$ then battery is removed and connected to uncharged capacitor $C_{2}$. Charge on the capacitor $C_{2}$ is
(1) $V_{0} \frac{C_{1} C_{2}}{C_{1}+C_{2}}$
(2) $V_{0} \frac{C_{1}+C_{2}}{C_{1} C_{2}}$
(3) $V_{0}\left(C_{1}+C_{2}\right)$
(4) $V_{0}\left(C_{1}-C_{2}\right)$

Answer (1)


Two capacitors will be finally in parallel
$\therefore$ Charge on capacitor $C_{2}$ is

$$
\begin{aligned}
& Q_{2}=\frac{C_{2}}{C_{1}+C_{2}} \times\left(C_{1} V_{0}\right) \\
\Rightarrow \quad & Q_{2}=\frac{C_{1} C_{2}}{C_{1}+C_{2}} V_{0}
\end{aligned}
$$

## SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. $06.25,07.00,-00.33,-00.30,30.27,-27.30$ ) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
21. An inductor of 100 mH was connected to 20 V battery. Internal resistance of inductor is $10 \Omega$. Suddenly switch is opened and current become zero in $100 \mu \mathrm{~s}$. Find induced emf (in Volts) in inductor.

## Answer (2)

Sol. Current in the circuit before switch is open is
$i=\frac{E}{R}=2 \mathrm{~A}$
This current becomes O in 100 ms so
$\frac{d i}{d t}=\frac{\Delta i}{\Delta t}=\frac{2-0}{100 \times 10^{-3}}=20 \mathrm{~A} / \mathrm{s}$

So emf $=L \frac{d i}{d t}=100 \times 10^{-3} \times 20=2 \mathrm{~V}$
22.
23.
24.
25.
26.
27.
28.
29.
30.

## CHEMISTRY

## SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

## Choose the correct answer :

1. Most stable enol form will be shown by which of the following?
(1)

(2)

(3)

(4)


## Answer (4)

Sol. Most stable enol form will be shown by


Enol form of

2.

(1)

(2)

(3)

(4)


## Answer (4)

Sol.

3. $\quad\left(\mathrm{C}_{2} \mathrm{H}_{5} \mathrm{O}_{2}\right)_{2} \xrightarrow{\mathrm{~h} \nu} \underset{\text { (Intermediate) }}{[\mathrm{]}} \longrightarrow \mathrm{C}_{6} \mathrm{H}_{5}+\mathrm{CO}_{2}$

The intermediate is
(1)

(2)

(3)

(4)


Answer (4)
Sol.

4. The correct order of melting point of group 16 elements is (oxygen family)
(1) $\mathrm{O}>\mathrm{S}>\mathrm{Se}>\mathrm{Te}$
(2) $\mathrm{Te}>\mathrm{Se}>\mathrm{S}>\mathrm{O}$
(3) $\mathrm{O}<\mathrm{S}>\mathrm{Se}>\mathrm{Te}$
(4) $\mathrm{O}<\mathrm{S}>\mathrm{Se}<\mathrm{Te}$

Answer (2)
Sol. Melting point of O, S, Se and Te are $55 \mathrm{~K}, 393 \mathrm{~K}$, 490 K and 725 K respectively.

Hence, correct order of melting point follows the order $\mathrm{O}<\mathrm{S}<\mathrm{Se}<\mathrm{Te}$
5. Pwhite + Alkali metal oxide / Hydroxide $\rightarrow$ Product The product is
(1) White $P$
(2) Red P
(3) $\mathrm{H}_{3} \mathrm{PO}_{3}$
(4) $\mathrm{H}_{2} \mathrm{PO}_{2}^{-}$

## Answer (4)

Sol.

6. Which of the following is responsible for secretion of pepsin?
(1) Histamine
(2) Anti-histamine
(3) Cimetidine
(4) Zantac

## Answer (1)

Sol. Histamine stimulates the secretion of pepsin and hydrochloric acid in stomach.
7. Which of the following set of match is correct?
(I) Copolymer - Buna-N
(II) Condensation Polymer - Nylon-6, 6
(III) Fibre - Nylon-6, 6
(IV) Thermosetting Polymer - Terylene.
(1) I, II, III
(2) II, III, IV
(3) I, II, IV
(4) I, III, IV

## Answer (1)

Sol. (I)

(II)

$\longrightarrow$ Nylon-6,6
(III) Nylon is fibre
(I), (II), (III) are correct

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8. Statement I : In Lassaigne's Test of organic compound including both N and S , sodium thiocyanate is formed
Statement II : Excess
$\mathrm{Na}+\mathrm{NaSCN} \longrightarrow \mathrm{Na}_{2} \mathrm{~S}+\mathrm{NaCN}$
The correct statements is/are
(1) Both (I) and (II)
(2) Only (I)
(3) Only (II)
(4) None of these

Answer (1)
Sol. First statement is correct


Second statement is also correct
9. The correct order of melting point of group 16 hydrides is
(1) $\mathrm{H}_{2} \mathrm{O}>\mathrm{H}_{2} \mathrm{~S}>\mathrm{H}_{2} \mathrm{Se}>\mathrm{H}_{2} \mathrm{Te}$
(2) $\mathrm{H}_{2} \mathrm{O}>\mathrm{H}_{2} \mathrm{Te}>\mathrm{H}_{2} \mathrm{Se}>\mathrm{H}_{2} \mathrm{~S}$
(3) $\mathrm{H}_{2} \mathrm{Te}>\mathrm{H}_{2} \mathrm{Se}>\mathrm{H}_{2} \mathrm{O}>\mathrm{H}_{2} \mathrm{~S}$
(4) $\mathrm{H}_{2} \mathrm{~S}>\mathrm{H}_{2} \mathrm{Te}>\mathrm{H}_{2} \mathrm{O}>\mathrm{H}_{2} \mathrm{Se}$

Answer (2)
Sol. Hydride - M.P.

| $\mathrm{H}_{2} \mathrm{O}$ | -273 K |
| :--- | ---: |
| $\mathrm{H}_{2} \mathrm{~S}$ | -188 K |
| $\mathrm{H}_{2} \mathrm{Se}$ | -208 K |
| $\mathrm{H}_{2} \mathrm{Te}$ | -222 K |

10. The correct decreasing order of the Bond order of the following species; $\mathrm{O}_{2}^{2-}, \mathrm{O}_{2}^{-}, \mathrm{O}_{2}, \mathrm{O}_{2}^{+}$
(1) $\mathrm{O}_{2}^{-}>\mathrm{O}_{2}^{2-}>\mathrm{O}_{2}>\mathrm{O}_{2}^{+}$
(2) $\mathrm{O}_{2}^{2-}>\mathrm{O}_{2}>\mathrm{O}_{2}^{+}>\mathrm{O}_{2}^{-}$
(3) $\mathrm{O}_{2}^{-}>\mathrm{O}_{2}>\mathrm{O}_{2}^{+}>\mathrm{O}_{2}^{2-}$
(4) $\mathrm{O}_{2}^{+}>\mathrm{O}_{2}>\mathrm{O}_{2}^{-}>\mathrm{O}_{2}^{2-}$

Answer (4)
Sol. Species Bond order

$$
\mathrm{O}_{2}^{+}=2.5
$$

$$
\mathrm{O}_{2}=2
$$

$$
\mathrm{O}_{2}^{-}=1.5
$$

$$
\mathrm{O}_{2}^{2-}=1
$$

11. The radius of third orbit of H -atom is $\mathrm{r}_{3} \mathrm{pm}$ and radius of fourth orbit of H -atom is $\mathrm{r}_{4} \mathrm{pm}$. The ratio of $r_{3}$ to $r_{4}$ is
(1) $9: 16$
(2) $16: 9$
(3) $4: 3$
(4) $3: 4$

Answer (1)
Sol. For H -atom, $\mathrm{Z}=1$
$r_{n} \propto \frac{n^{2}}{Z}$
$\frac{r_{3}}{r_{4}}=\frac{3^{2}}{4^{2}}=\frac{9}{16}$
12. Statement 1 : As the value of $\Delta G^{\circ}$ decreases, the metal oxide becomes more stable.

Statement 2 : As the value of $\Delta \mathrm{G}^{\circ}$ increases, then the metal having lower value of $\Delta G^{\circ}$ displaces the other metal.

The correct statements is/are
(1) Both (1) and (2)
(2) Only (1)
(3) Only (2)
(4) Neither (1) nor (2)

## Answer (1)

Sol. Statement 1 : As the value of $\Delta G^{\circ}$ decreases, the metal oxide becomes more stable.

Statement 2 : As the value of $\Delta G^{\circ}$ increases, then the metal having lower value of $\Delta G^{\circ}$ displaces the other metal.

Both the statements 1 and 2 are correct.
13. Which of the following is wrong about Brown ring test?
(i) Brown ring forms at junction of two solutions
(ii) The brown ring complex is $\left[\mathrm{Fe}\left(\mathrm{H}_{2} \mathrm{O}\right)_{5} \mathrm{NO}_{\mathrm{N}} \mathrm{SO}_{4}\right.$
(iii) It consists of ferrous nitro sulphate complex
(iv) $\mathrm{NO}_{3}^{-}+\underset{\substack{\mathrm{H}_{2} \mathrm{SO}_{4} \text {.) }}}{\mathrm{H}_{4}} \rightarrow$ Brown fumes are evolved
(1) i
(2) ii
(3) iii
(4) 4

## Answer (3)

Sol. Nitrate ions react with $\mathrm{FeSO}_{4}$ in presence of conc. $\mathrm{H}_{2} \mathrm{SO}_{4}$ form a brown ring complex at the junction of the two solutions.
$\mathrm{NO}_{3}^{-}+\mathrm{H}_{2} \mathrm{SO}_{4} \rightarrow \mathrm{HNO}_{3}+\mathrm{HSO}_{4}^{-}$
$6 \mathrm{FeSO}_{4}+3 \mathrm{H}_{2} \mathrm{SO}_{4}+2 \mathrm{HNO}_{3}$

$$
\begin{aligned}
& \rightarrow 3 \mathrm{Fe}_{2}\left(\mathrm{SO}_{4}\right)_{3}+2 \mathrm{NO}+4 \mathrm{H}_{2} \mathrm{O} \\
\mathrm{NO}+\mathrm{FeSO}_{4}+5 \mathrm{H}_{2} \mathrm{O} & \rightarrow\left[\mathrm { Fe } \left(\underset{\substack{\left.\left(\mathrm{H}_{2} \mathrm{O}_{5}\right)_{5} \mathrm{NO}_{(\text {Brown ring }}\right)}}{ } \mathrm{SO}_{4}\right.\right.
\end{aligned}
$$

Option (3) is incorrect
14. Spin only magnetic moment of oxide. Which is most basic among $\mathrm{V}_{2} \mathrm{O}_{3}, \mathrm{~V}_{2} \mathrm{O}_{4}, \mathrm{~V}_{2} \mathrm{O}_{5}$
(1) 4.12 BM
(2) 2.83 BM
(3) 1.24 BM
(4) 3.91 BM

## Answer (2)

Sol. $\mathrm{V}_{2} \mathrm{O}_{3}$ is most basic out of the given oxides electronic configuration of $\mathrm{V}+3$ is $[\mathrm{Ar}] 3 \mathrm{~d}^{2}$
Spin only magnetic moment will be

$$
\sqrt{2(2+2)}=\sqrt{8}=2.83 \text { B.M. }
$$

15. Order of stability of +1 oxidation state of $13^{\text {th }}$ group is,
(1) $\mathrm{Ga}>\mathrm{In}>\mathrm{TI}>\mathrm{Al}$
(2) $\mathrm{TI}>\mathrm{In}>\mathrm{Ga}>\mathrm{Al}$
(3) $\mathrm{In}>\mathrm{TI}>\mathrm{Al}>\mathrm{Ga}$
(4) $\mathrm{Al}>\mathrm{Ga}>\mathrm{In}>\mathrm{TI}$

## Answer (2)

Sol. The stability of +1 oxidation state increases down the group due to inert pair effect. So the correct order is, $\mathrm{TI}>\mathrm{In}>\mathrm{Ga}>\mathrm{Al}$
16. The increasing order of melting point of alkaline earth metals is
(1) $\mathrm{Mg}<\mathrm{Ca}<\mathrm{Sr}<\mathrm{Be}$
(2) $\mathrm{Mg}<\mathrm{Sr}<\mathrm{Ca}<\mathrm{Be}$
(3) $\mathrm{Be}<\mathrm{Sr}<\mathrm{Ca}<\mathrm{Mg}$
(4) $\mathrm{Sr}<\mathrm{Be}<\mathrm{Mg}<\mathrm{Ca}$

Answer (2)

| Sol. Alkaline earth metals | M.P. |
| :--- | :--- |
| Be | -1560 K |
| Mg | -924 K |
| Ca | -1124 K |
| Sr | -1062 K |

17. $35 \%$ by mass of HCl solution has density $1.46 \mathrm{~g} / \mathrm{ml}$.

Find the molarity.
(1) 12 M
(2) 14 M
(3) 9 M
(4) 16 M

Sol. Since, the solution is $35 \%$ by mass in terms of HCl .
Hence, volume of solution $=\frac{100}{1.46} \mathrm{ml}$
Molarity $=\frac{35}{36.5} \times \frac{1000}{\left(\frac{100}{1.46}\right)}=14 \mathrm{M}$
18. Ethylanthraquinol is oxidised to form ethylanthraquinone and compound X . The dihedral angle of $X$ in solid state is
(1) $111.5^{\circ}$
(2) $90.2^{\circ}$
(3) $95.8^{\circ}$
(4) $101.9^{\circ}$

Answer (2)
Sol. 2-ethylanthraquinol $\stackrel{\mathrm{O}_{2} \text { Air }}{\rightleftarrows}$ et hylanthraquinone +x (Product), x is $\mathrm{H}_{2} \mathrm{O}_{2}$


$\mathrm{H}_{2} \mathrm{O}_{2}$ structure in solid state dihedral angle is $90.2^{\circ}$ 19.
20.

## SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. $06.25,07.00,-00.33,-00.30,30.27,-27.30$ ) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
21. $0.5 \% \mathrm{KCl}$ solution has freezing point -0.24 . Calculate the value of degree of dissociation of KCl . Given: $\mathrm{K}_{\mathrm{f}}($ water $)=1.86^{\circ} \mathrm{K} \mathrm{kg} \mathrm{mol}^{-1}$

## Answer (0.91)

Sol. Molality of $\mathrm{KCI}=\frac{0.5 \times 1000}{74.5 \times 99.5}=0.067$
$\Delta \mathrm{T}_{\mathrm{f}}=0.24 \mathrm{~K}$
$\Delta \mathrm{T}_{\mathrm{f}}=\mathrm{i} \mathrm{K}_{\mathrm{f}} \mathrm{m}$
$0.24=i \times 1.86 \times 0.067$
$\mathrm{i}=1.91$
$\underset{1-\alpha}{\mathrm{KCl}} \rightleftharpoons \underset{\alpha}{\mathrm{K}^{+}}+\mathrm{Cl}_{\alpha}^{-}$
$\mathrm{i}=1+\alpha=1.91$
$\alpha=0.91$
22. 0.30 g of organic compound on combustion gives 0.20 g of $\mathrm{CO}_{2}$ and 0.10 g of $\mathrm{H}_{2} \mathrm{O}$ and side products. Find the percentage by mass of carbon present in the organic compound.
[Round off to the nearest integer]

## Answer (18)

Sol. $\%$ of carbon $=\frac{0.20 \times 12}{44 \times 0.3} \times 100=18.18 \simeq 18$
23. Consider the following radioactive decay,

$$
{ }_{92}^{238} \mathrm{U} \longrightarrow{ }^{206} \mathrm{~Pb}
$$

Find the total number of $\alpha$ and $\beta$ particles emitted.

## Answer (14)

Sol. Let's assume no. of $\alpha$ particles emitted are $x$ and no. of $\beta$ particles emitted are $y$.
${ }_{92}^{238} \mathrm{U} \longrightarrow{ }_{82}^{206} \mathrm{~Pb}+\mathrm{x}_{2}^{4} \mathrm{He}+\mathrm{y}{ }_{-1}^{0} \mathrm{e}$
$82+2 x-y=92$
$4 x+206=238$
$x=8$ and $y=6$
Sum of $\alpha$ and $\beta$ particles emitted is 14 .
24.
25.
26.
27.
28.
29.
30.

## MATHEMATICS

## SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

## Choose the correct answer :

1. If a biased coin is tossed 5 times, and if the probability of getting 4 heads is equal to the probability of getting 5 heads, then the probability of getting atmost 2 heads is
(1) $\frac{46}{6^{4}}$
(2) $\frac{275}{6^{5}}$
(3) $\frac{41}{5^{5}}$
(4) $\frac{36}{5^{4}}$

## Answer (1)

Sol. Let the probability of getting head be $p$.
$\because{ }^{5} C_{4} p^{4}(1-p)={ }^{5} C_{5} . p^{5}$
$\Rightarrow 5-5 p=p \Rightarrow p=\frac{5}{6}$
Now probability of getting atmost 2 heads
$={ }^{5} C_{0 .}(1-p)^{5}+{ }^{5} C_{1} p(1-p)^{4}+{ }^{5} C_{2} p^{2}(1-p)^{3}$
$=\left(\frac{1}{6}\right)^{5}+\frac{25}{6^{5}}+\frac{250}{6^{5}}$
$=\frac{276}{6^{5}}=\frac{46}{6^{4}}$
2. The vertex of an equilateral triangle is $(3,7)$ and equation of opposite side is $x+y=5$, then area of the triangle is
(1) $\frac{25}{\sqrt{3}}$
(2) $\frac{25}{2 \sqrt{3}}$
(3) $25 \sqrt{3}$
(4) 25

## Answer (2)

Sol. $R T=\frac{5}{\sqrt{2}}$

$\therefore$ area of $\triangle P Q R$

$$
\begin{aligned}
& =\frac{1}{2} \cdot \frac{2 h}{\sqrt{3}} \times h \\
& =\frac{h^{2}}{\sqrt{3}}=\frac{25}{2 \sqrt{3}} \text { sq.units }
\end{aligned}
$$

3. The area of region bounded by curve $y=\left|x^{2}-9\right|$ and line $y=3$ is
(1) $4[2 \sqrt{3}+\sqrt{6}-3]$
(2) $8[4 \sqrt{3}-\sqrt{6}+9]$
(3) $4[2 \sqrt{3}+\sqrt{6}+9]$
(4) $8[4 \sqrt{3}+2 \sqrt{6}-9]$

Answer (4)
Sol.


Area of shaded region
(Required Area)
$=2\left[\int_{0}^{3}(\sqrt{9+y}-\sqrt{9-y}) d y+\int_{3}^{9}(\sqrt{9-y}) d y\right]$
$=2\left[\frac{2}{3}\left[(9+y)^{\frac{3}{2}}+(9-y)^{\frac{3}{2}}\right]_{0}^{3}-\left[\frac{2}{3}(9-y)^{\frac{3}{2}}\right]_{3}^{9}\right]$
$=\frac{4}{3}\left[\left((12)^{\frac{3}{2}}+6^{\frac{3}{2}}\right)-\left(9^{\frac{3}{2}}+27\right)-\left\{0-6^{\frac{3}{2}}\right\}\right]$
$=\frac{4}{3}[24 \sqrt{3}+6 \sqrt{6}-54+6 \sqrt{6}]=8[4 \sqrt{3}+2 \sqrt{6}-9]$

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4. The value of $\lim _{x \rightarrow \frac{1}{\sqrt{2}}} \frac{\sin \left(\cos ^{-1} x\right)-x}{1-\tan \left(\cos ^{-1} x\right)}$ is
(1) $\frac{1}{2 \sqrt{2}}$
(2) $\frac{-1}{2 \sqrt{2}}$
(3) $\frac{-1}{\sqrt{2}}$
(4) $-\sqrt{2}$

## Answer (2)

Sol. $\lim _{x \rightarrow \frac{1}{\sqrt{2}}} \frac{\sin \left(\cos ^{-1} x\right)-\frac{1}{\sqrt{2}}}{1-\tan \left(\cos ^{-1} x\right)}, \quad$ let $\cos ^{-1} x=\theta+\frac{\pi}{4}$
$\lim _{\theta \rightarrow 0} \frac{\sin \left(\theta+\frac{\pi}{4}\right)-\frac{1}{\sqrt{2}}}{1-\tan \left(\theta+\frac{\pi}{4}\right)}=\lim _{\theta \rightarrow 0} \frac{\frac{1}{\sqrt{2}}[\sin \theta+\cos \theta-1]}{1-\frac{1+\tan \theta}{1-\tan \theta}}$
$=\lim _{\theta \rightarrow 0} \frac{(1-\tan \theta)}{\sqrt{2}} \cdot \frac{\left(2 \sin \frac{\theta}{2} \cos \frac{\theta}{2}-2 \sin ^{2} \frac{\theta}{2}\right)}{-2 \tan \theta}$
$=\lim _{\theta \rightarrow 0}-\frac{1}{2 \sqrt{2}} \cdot \frac{2 \sin \frac{\theta}{2}}{\tan \theta} \cdot\left(\cos \frac{\theta}{2}-\sin \frac{\theta}{2}\right)$
$=-\frac{1}{2 \sqrt{2}} \times 2\left(\frac{1}{2}\right) \times 1$
$=-\frac{1}{2 \sqrt{2}}$
5. The sum of absolute minimum and absolute maximum value of $f(x)=\left|3 x-x^{2}+2\right|-x$ for $x \in[-1,2]$ is
(1) 1
(2) 0
(3) $\frac{\sqrt{17}+3}{2}$
(4) $\frac{\sqrt{17}-3}{2}$

## Answer (3)

Sol. $f(x)=\left|3 x-x^{2}+2\right|-x=\left|x^{2}-3 x-2\right|-x$
As critical points of $3 x-x^{2}+2$ are $\frac{3+\sqrt{17}}{2}, \frac{3-\sqrt{17}}{2}$
The given function is defined as below

$f(x)=x^{2}-4 x-2 \quad f(x)=-x^{2}+2 x+2 \quad f(x)=x^{2}-4 x-2$

$\therefore$ Absolute maximum value is 3
And absolute minimum value is $\frac{\sqrt{17}-3}{2}$
Sum of absolute maximum and absolute minimum is $\frac{\sqrt{17}+3}{2}$
6. $\frac{x}{a}+\frac{y}{b}=2$ tangent $\left(\frac{x}{a}\right)^{n}+\left(\frac{y}{b}\right)^{n}=2$ at $(\alpha, \beta) n \in s$, find $s$
(1) $\phi$
(2) $\{1\}$
(3) $\{2 K, \mid K \in N\}$
(4) $N$

## Answer (4)

Sol. $\left(\frac{x}{a}\right)^{n}+\left(\frac{y}{b}\right)^{n}=2$
Differentiating w.r.t. $x$,
$\frac{n}{a}\left(\frac{x}{a}\right)^{n-1}+\frac{n}{b}\left(\frac{y}{b}\right)^{n-1} \quad y^{\prime}=0$
At $(a, b) \quad y^{\prime}=\frac{-b}{a}$
Equation ${ }^{n}$ of tangent is given by
$y-b=\frac{-b}{a}(x-a)$
$\Rightarrow \frac{x}{a}+\frac{y}{b}=2$
7. If $f(x)=\frac{x-1}{x+1}, f^{n+1}(x)=f\left(f^{n}(x)\right) \forall n \in N$, then the value of $f(6)+f(7)$ is
(1) $-\frac{3}{2}$
(2) $-\frac{2}{3}$
(3) $\frac{2}{3}$
(4) $\frac{3}{2}$

## Answer (1)

Sol. $\because \quad f(x)=\frac{x-1}{x+1}=f^{1}(x)$

$$
\begin{aligned}
& f^{2}(x)=f(f(x))=\frac{\frac{x-1}{x+1}-1}{\frac{x-1}{x+1}+1}=-\frac{1}{x} \\
& f^{3}(x)=f\left(f^{2}(x)\right)=-\frac{x+1}{x-1} \\
& f^{4}(x)=f\left(f^{3}(x)\right)=-\frac{\frac{x-1}{x+1}+1}{\frac{x-1}{x+1}+1}=x \\
\therefore \quad & f^{6}(x)=-\frac{1}{x} \Rightarrow f^{6}(6)=-\frac{1}{6}
\end{aligned}
$$

$$
\text { and } f^{7}(x)=-\frac{x+1}{x-1} \Rightarrow f^{7}(7)=-\frac{7+1}{7-1}=-\frac{8}{6}
$$

$$
\therefore \quad f^{6}(6)+f^{7}(7)=-\frac{1}{6}-\frac{8}{6}=-\frac{9}{6}=\frac{-3}{2}
$$

8. $\quad \frac{d y}{d x}=\frac{1}{1+\sin 2 x} ; y\left(\frac{\pi}{4}\right)=\frac{1}{2}$;

$$
x \in(0,2 \pi)-\left\{\frac{\pi}{2}, \frac{3 \pi}{2}, \frac{3 \pi}{4}, \frac{7 \pi}{4}\right\}
$$

and $y(x)=\sqrt{2} \sin x$
Find the sum of $x$-coordinates of point of intersection of given curves.
(1) $\frac{7 \pi}{2}$
(2) $\frac{7 \pi}{3}$
(3) $\frac{9 \pi}{4}$
(4) $\frac{9 \pi}{2}$

## Answer (1)

Sol. $d y=\frac{d x}{1+\sin 2 x}=\frac{d x}{1+2 \sin x \cos x}$
$\Rightarrow d y=\frac{\sec ^{2} x d x}{1+2 \tan x+\tan ^{2} x}$

Let $\tan x=t$
$\Rightarrow \quad d y=\frac{d t}{(1+t)^{2}}$
$\Rightarrow \quad y=\frac{-1}{1+\tan x}+c$
At $x=\frac{\pi}{4}$
$\frac{1}{2}=-\frac{1}{2}+c \Rightarrow c=1$
$y=\frac{-1}{1+\tan x}+1=\frac{\tan x}{\tan x+1}$
For point of intersection
$\frac{\tan x}{\tan x+1}=\sqrt{2} \sin x$
$\Rightarrow \frac{\sin x}{\sin x+\cos x}=\sqrt{2} \sin x$
$\Rightarrow \sin x=0$ or $\sin x+\cos x=\frac{1}{\sqrt{2}}$
$\Rightarrow x=\pi, \frac{7 \pi}{12}, \frac{23 \pi}{12} \Rightarrow$ Sum of $x$-coordinates $=\frac{7 \pi}{2}$.
9. If $\sin ^{2} 10^{\circ} \cdot \sin 20^{\circ} \cdot \sin 40^{\circ} \cdot \sin 50^{\circ} \sin 70^{\circ}=\alpha-\frac{1}{16} \sin 10^{\circ}$ then find the value of $\alpha^{-1}+16$
(1) 80
(2) 60
(3) 64
(4) 16

Answer (1)
Sol. $\sin ^{2} 10^{\circ} \sin 20^{\circ} \sin 40^{\circ} \sin 50^{\circ} \sin 70^{\circ}$
$=\sin 10^{\circ} \sin 20^{\circ} \sin 40^{\circ} \sin 10^{\circ} \sin 50^{\circ} \sin 70^{\circ}$
$=\frac{1}{8} \cdot \frac{1}{2} \sin 10^{\circ}\left[\cos 20^{\circ}-\frac{1}{2}\right]$
$=\frac{1}{16}\left[\frac{1}{2} 2 \sin 10^{\circ} \cos 20^{\circ}-\frac{1}{2} \sin 10^{\circ}\right]$
$=\frac{1}{16}\left[\frac{1}{2}\left(\sin 30^{\circ}-\sin 10^{\circ}\right)-\frac{1}{2} \sin 10^{\circ}\right]$
$=\frac{1}{64}-\frac{1}{16} \sin 10^{\circ}$
$\therefore \quad \alpha=\frac{1}{64} \Rightarrow 16+64$
$=80$
10. Normal to $y^{2}=6 x$ at $P$, passes through $(5,-8)$ then ordinate of point of intersection of directrix and tangent at $P$ is
(1) $\frac{9}{4}$
(2) $\frac{-9}{4}$
(3) $\frac{-9}{2}$
(4) $\frac{9}{2}$

## Answer (2)

Sol. Equation of normal (in slope form)
$y=m x-3 m-\frac{3}{2} m^{3}$
$\because$ It passes through $(5,-8)$
$\therefore \quad-8=2 m-\frac{3}{2} m^{3}$
$\therefore \quad m=2$
Now, tangent at $P: y=m_{1} x+\frac{3}{2 m_{1}},\left(m_{1}=\frac{-1}{2}\right)$
$\therefore \quad y=\frac{-1}{2} x-3$
Equation of directrix : $x=\frac{-3}{2}$
$\therefore$ Ordinate of intersection point $Q=\frac{-9}{4}$
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.

## SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10 . The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. $06.25,07.00,-00.33,-00.30,30.27,-27.30$ ) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
21. From a group of 10 boys $B_{1}, B_{2}$ $\qquad$ $B_{10}$ and 5 girls $G_{1}, G_{2}$ $\qquad$ $G_{5}$, the number of ways of selection of group of 3 boys and 3 girls, such that $B_{1} \& B_{2}$ are not together in group

## Answer (1120)

Sol. Number of ways to select 3 boys
$=$ Total ways - No. of ways when $B_{1}$ and $B_{2}$ are both selected

$$
={ }^{10} C_{3}-{ }^{8} C_{1}=112
$$

Number of ways to select 3 girls $={ }^{5} C_{3}=10$
Required number of ways $=112 \times 10=1120$
22. Find the remainder when $(2021)^{2023}$ is divided by 7 .

## Answer (05)

Sol. $(2021)^{2023}=(7 k-2)^{2023}$

$$
\begin{align*}
& ={ }^{2023} C_{0}(7 k)^{2023}-{ }^{2023} C_{1}(7 k)^{2022} \cdot 2 \\
& \\
& \quad+\ldots . .+(-2)^{2023}  \tag{i}\\
& =7 \lambda-2^{2023} \quad \ldots \text { (i) }
\end{align*}
$$

$$
\begin{aligned}
2^{2023} & =2(8)^{674} \\
& =2(7+1)^{674} \\
& =2\left[{ }^{7} C_{0} 7^{674}+{ }^{7} C_{1} 7^{673}+\ldots .+1\right] \\
& =2\left[7 \lambda_{1}+1\right]
\end{aligned}
$$

Put in (i)

$$
\begin{aligned}
& (2021)^{2023}=7 \lambda-14 \lambda_{1}-2+7-7 \\
& =7(\mathrm{~m})+5
\end{aligned}
$$

$\therefore \quad$ remainder $=5$
23. Let $a=\sum_{i=1}^{10} \sum_{j=1}^{10} \min (i, j)$ and $b=\sum_{i=1}^{10} \sum_{j=1}^{10} \max (i, j)$.

The value of $(a+b)$ is

## Answer (1100)

Sol. $\therefore$ In the expansion of $\sum_{i=1}^{10} \sum_{j=1}^{10}(i, j)$ there are 100 ordered pairs and each element of every ordered pair which is available is either $a$ or $b$.

So, $a+b=2[10(1+2+3+\ldots+10)]$

$$
=1100
$$

24. $S_{1}=\{n \mid \operatorname{HCF}(n, 45)=1\}$
$S_{2}=\{2 k \mid k \in\{1,2, \ldots 10\}\}$
then $n\left(S_{1} \cap S_{2}\right)$ is equal to

## Answer (5)

Sol. $S_{2}=\{2,4,6,8,10,12,14,16,18,20\}$
Elements which are having HCF with 45 as 1 are
$S_{1} \cap S_{2}=\{2,4,8,14,16\}$
$n\left(S_{1} \cap S_{2}\right)=5$
25. Let $f(x)=\max \{|x+1|,|x+2|,|x+3|,|x+4|,|x+5|\}$ then the value of $\int_{-6}^{0} f(x) d x$ is

Answer (21)

Sol.


Clearly $\int_{-6}^{0} f(x) d x=\int_{-6}^{-3}-(x+1) d x+\int_{-3}^{0}(x+5) d x$

$$
\begin{aligned}
& =-\left.\frac{(x+1)^{2}}{2}\right|_{-6} ^{-3}+\left.\frac{(x+5)^{2}}{2}\right|_{-3} ^{0} \\
& =\left(\frac{25-4}{2}\right)+\left(\frac{25-4}{2}\right)=21
\end{aligned}
$$

26. If mean of 5 elements $a, b, 8,5,10$ is 6 and variance is $6 \cdot 8$, then mean deviation about mean is $M$ then 25 M is

## Answer (60)

Sol. $\because a+b+8+5+10=5 \times 6$
$\Rightarrow a+b=7$
$\because \quad \frac{a^{2}+b^{2}+5^{2}+8^{2}+10^{2}}{5}-6^{2}=6 \cdot 8$
$\Rightarrow a^{2}+b^{2}=25$
So, $(a, b)=(4,3)$ or $(3,4)$
Now mean deviation about mean,
$M=\frac{1}{5}((6-3)+(6-4)+(6-5)+(8-6)+(10-6))$
$=\frac{12}{5}$

Hence $25 M=60$
27. The value of $[\vec{a} \times(\vec{b} \times \vec{c}) \vec{b} \times(\vec{c} \times \vec{a}) \vec{c}(\vec{a} \times \vec{b})]$ for $\vec{a} \cdot \vec{b}=1, \vec{b} \cdot \vec{c}=2, \vec{a} \cdot \vec{c}=3$ is equal to

## Answer (0)

Sol. $\because \vec{a} \times(\bar{b} \times \bar{c})=3 \vec{b}-\vec{c}$
$\bar{b} \times(\bar{c} \times \bar{a})=\vec{c}-2 \vec{a}$
$\bar{c} \times(\bar{a} \times \bar{b})=2 \vec{a}-3 \vec{b}$

$$
\text { Now, }\left[\begin{array}{lll}
3 \vec{b}-\vec{c} & \vec{c}-2 \vec{a} & 2 \vec{a}-3 \vec{b}
\end{array}\right]=0
$$

Because sum of these 3 vectors is zero hence these three vectors are coplanar.
28. $A 3 \times 3$ invertible matrices given $[A]$. If $|\operatorname{adj} 24 A|=$ $|\operatorname{adj} 3(\operatorname{adj} 2 A)|$, then $|A|^{2}$ is

## Answer (64)

Sol. $|\operatorname{adj} 24 A|=|\operatorname{adj} 3(\operatorname{adj} 2 A)|$

$$
\begin{aligned}
& \Rightarrow \quad\left(24^{3}|A|\right)^{2}=\left(3^{3}|\operatorname{adj} 2 A|\right)^{2} \\
& \Rightarrow \quad 24^{6}|A|^{2}=3^{6}\left(2^{6}|A|^{2}\right)^{2} \\
& \Rightarrow \quad 2^{18} \cdot 3^{6}=3^{6} 2^{12}|A|^{2} \\
& \Rightarrow \quad|A|^{2}=2^{6}=64
\end{aligned}
$$

29. Find the value of $\frac{48}{\pi^{4}} \int_{0}^{\pi}\left(\frac{3 \pi}{2} x^{2}-x^{3}\right) \frac{\sin x}{1+\cos ^{2} x} d x$.

## Answer (6)

Sol. $I=\int_{0}^{\pi}\left(\frac{3 \pi}{2} x^{2}-x^{3}\right) \frac{\sin x}{1+\cos ^{2} x} d x$

$$
\begin{align*}
& \left(\frac{\pi}{2}-x\right)^{3}=\frac{\pi^{3}}{8}-\frac{3 \pi^{2}}{4} x+\frac{3 \pi x^{2}}{2}-x^{3} \\
& I=\int_{0}^{\pi}\left(\left(\frac{\pi}{2}-x\right)^{3}-\frac{\pi^{3}}{8}+\frac{3 \pi^{2}}{4} x\right) \frac{\sin x}{1+\cos ^{2} x} d x \tag{i}
\end{align*}
$$

By applying $f(x) \rightarrow f(a+b-x)$

$$
\begin{equation*}
I=\int_{0}^{\pi}\left(-\left(\frac{\pi}{2}-x\right)^{3}-\frac{\pi^{3}}{8}+\frac{3 \pi^{2}}{4}(\pi-x)\right) \frac{\sin x}{1+\cos ^{2} x} d x \tag{ii}
\end{equation*}
$$

Equation (i) + (ii)
$2 I=\int_{0}^{\pi} \frac{\pi^{3}}{2} \frac{\sin x}{1+\cos ^{2} x} \cdot d x$
$I=\frac{\pi^{3}}{4} \int_{0}^{\pi} \frac{\sin x}{1+\cos ^{2} x} d x=\left.\frac{\pi^{3}}{4}\left(-\tan ^{-1}(\cos x)\right)\right|_{0} ^{\pi}$
$=\frac{\pi^{3}}{4}\left(\frac{\pi}{4}+\frac{\pi}{4}\right)=\frac{\pi^{4}}{8}$

So $\frac{48}{\pi^{4}} I=6$
30.

